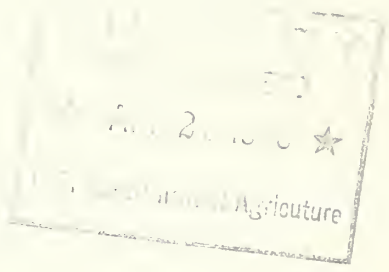
REDUCING DUST EXPLOSION LOSSES IN INDUSTRIAL PLANTS



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RELATION OF DUST EXPLOSIONS TO FIRE LOSSES

The preliminary estimate of the fire loss in the United States for the year 1939, based on estimates compiled by the National Board of Fire Underwriters is $317,539,640. According to the National Fire Protection Association this estimate is $15,000,000 greater than the 1938 preliminary loss estimate.

This 1939 fire loss brings the total fire waste in the United States during the past 24 years up to $9,518,160,735 - an average annual loss of about $400,000,000. In six of these years - 1922, 1923, 1924, 1925, 1926, and 1930 - the fire loss exceeded $500,000,000 for each year.

During 1939 there were reported to the National Fire Protection Association 21 fires in the United States, each involving a loss estimated at not less than $250,000. Ten of these fires resulted in a loss of more than $500,000, including three which caused a loss of $1,000,000 or more. The largest fire loss in 1939 was the fire following the dust explosion in the Chicago grain elevators on May 11, 1939. That explosion and fire caused the loss of nine lives and property loss of approximately $3,500,000. It is therefore very timely for this meeting to direct attention to the importance of dust explosion and fire prevention in industrial plants, and to consider the progress that has been made in the reduction of losses from dust explosions and fires in industry.

RESEARCH HAS BEEN EFFECTIVE

As a result of research studies in the U. S. Department of Agriculture information has been compiled on the extent to which dust explosions have occurred, particularly in grain-handling and milling operations; data have been secured on conditions under which dust explosions can occur; and methods have been developed for their control and prevention.

For instance, in the 20-year period from 1919 to 1938, inclusive, the Chemical Engineering Research Division of the Bureau of Agricultural Chemistry and Engineering has investigated or studied 398 dust explosions to determine the causes and to obtain information which would assist in developing methods of preventing such explosions in industrial plants. In the 398 cases reported to the Bureau, and for which accurate records are available, 318 lives were lost, 712 persons were injured, and the property loss amounted to $28,302,685. In examining these reports it will be found that these dust explosions occurred in a wide range of industries, including flour and feed mills, grain elevators, starch factories, sugar refineries, woodworking plants, powdered milk plants, soap powder factories, sulphur crushing and pulverizing plants, cork grinding mills, chocolate and cocoa plants, paper mills, aluminum, zinc, and magnesium plants, rosin-handling plants, fertilizer plants, and many others. It must therefore be recognized that under favorable conditions a dust explosion can occur in any industrial plant or establishment where combustible dust is produced.

The research work on the study of the behavior of dust explosions has given considerable information on:

1. Quantity of dust necessary to form an explosive mixture with air
2. The type and temperature of ignition sources required to initiate an explosion
3. The rate of flame propagation
4. Maximum pressures produced
5. Rate of pressure rise
6. Other factors relating to degree of explosibility of the dust.

SAFETY CODES FOR DUST EXPLOSION PREVENTION

The actual translation of the results of technical research to practical industrial plant application is of fundamental importance. A striking example of how this can be done in an effective manner is very positively indicated in the safety code work of the Dust Explosion Hazards Committee of the National Fire Protection Association.

This committee, which works under the leadership of the U. S. Department of Agriculture, was organized to obtain information on dust explosion prevention and to make it available to the industries affected. The membership of the committee includes representatives of a wide variety of organizations directly concerned with the problem.

The work of the committee has been directed principally toward the preparation of safety codes which make available to plant owners and operators the results of research work on dust explosion prevention and recommendations of the committee for the adoption of safe practices designed to eliminate or reduce the dust explosion hazard.

The following safety codes developed by the Dust Explosion Hazards Committee have been adopted by the National Fire Protection Association and the National Board of Fire Underwriters, and approved as "American Standards" by the American Standards Association:

1. Flour and feed mills
2. Sugar and cocoa pulverizing
3. Pulverized fuel installations
4. Terminal grain elevators
5. Starch factories
6. Coal pneumatic cleaning plants
7. Wood flour manufacturing establishments
8. Spice-grinding plants
9. Wood-working plants
10. Use of inert gas for fire and explosion prevention
11. Aluminum-bronze powder manufacturing plants.

A safety code for the prevention of dust explosions in the handling, grinding, and storing of sulphur has been recently prepared by this committee as well as an outline of Fundamental Principles for the Prevention of Dust Explosions in Industrial Plants not covered by special codes. These codes have just been made available by the National Fire Protection Association in a publication entitled, "National Fire Codes for the Prevention of Dust Explosions."

SAFETY CODE FOR ALUMINUM BRONZE POWDER MANUFACTURE

The preparation of the new Safety Code for the Prevention of Dust Explosions in the Manufacture of Aluminum Bronze Powder, which has been recently approved as "American Standard," is a fine example of the spirit of cooperation on the part of the representatives of the industry. In their desire to provide the maximum safety possible in order to guard against the dust explosion hazard, these representatives wrote into this code recommendations covering the installation of electrical equipment which went beyond the requirements of the existing electrical code. The National Electrical Code has since been amended to include these suggestions. It is this spirit of cooperation on the part of industry which has made possible a marked reduction in our dust explosion losses.

The aluminum code is of special importance at this time because it represents the first work of the committee dealing with non-carbonaceous dust. It will be recalled that aluminum, a metal, was not considered a combustible material, or at least it did not fit in the original definition which explained that any combustible material fine enough and dry enough to form a cloud in air could be ignited and would explode with violence under favorable conditions.

Laboratory tests had shown that aluminum powder could be ignited and would explode with violence. Actual explosions in aluminum plants, particularly the aluminum-bronze producing sections, had proved that a serious hazard to life and property existed in such plants unless protective measures were adopted. With the help and advice of representatives of the aluminum bronze-producing industry serving on a subcommittee under the direction of Dr. George S. Rice, formerly chief mining engineer of the U. S. Bureau of Mines, a safety code was prepared. After more than two years' consideration it was presented in May, 1939, to the National Fire Protection Association for adoption. The new code follows the general pattern of the other dust explosion prevention codes, but makes specific recommendations covering the location and construction of buildings, the making and handling of the powder, the location of electrical equipment, the elimination of sources of ignition, and fire-fighting methods.

REDUCTION IN DUST EXPLOSION LOSSES

There has been a very noticeable reduction in dust explosion losses during the last 10 years as compared with the previous 10 years. When it is realized that roughly this is the period during which the safety codes have been in effect, these figures offer considerable encouragement to

those who have been working earnestly to develop methods of providing protection against the dust explosion hazard in industrial plants. The following table shows the extent of this reduction both in the number of explosions and of losses incurred:

	No. of Explosions	No. Killed	No. Injured	Property Loss
1919-1928, inclusive	217	193	362	$18,249,900
1929-1938, "	181	125	350	10,052,785
Reduction	36	68	12	$ 8,197,115

It is particularly significant to note the reduction of more than $8,000,000 in property losses in the last 10 years, which is an average reduction of over $800,000 annually.

These reductions in dust explosion and fire losses as well as the saving in insurance costs which have ensued due to a reduction in rates for the application of dust explosion and fire prevention methods, show definitely the economic value of this research work.

IMPORTANCE OF CONTINUED SAFETY EDUCATION

After all these research studies, it would appear reasonable to expect that the officials and employees in industrial plants where explosive dusts are produced would be fully informed as to the hazards of dust explosions and the methods that should be employed for their prevention or control. However, the investigation of some recent explosions has definitely indicated that many of the younger employees in a number of industrial plants have not had occasion to become familiar with the dust explosion hazard, and that the educational work carried on twenty years ago must be resumed with the oncoming generation.

Fire protection and explosion prevention, while technical in many of their aspects, rest fundamentally upon public education; it is only when these subjects are understood that the necessary impetus is given for the application of technical measures of fire prevention and fire protection. It is very important to remember that public education, or even education of a limited group, must be continuous to be effective. For instance, a given group of employees in some recognized hazardous industry may be fully informed as to the importance of fire and explosion safety measures, with resultant notable decrease in fire and explosion losses, but as a new generation comes into the industry educational activities must be continued in order to maintain the improved record. A striking example of this is furnished in the field of dust explosion prevention.

GRAIN ELEVATOR LOSSES

Although losses from dust explosions have been reduced materially in many of the food-manufacturing industries which have cooperated in working out and adopting practical safety and preventive measures against dust explosions and resulting fires, there is still need for more definite attention to the development and application of methods for the control

and prevention of dust explosions in grain elevators. Since 1930, 56 grain elevator explosions have been reported. In those explosions 40 people were killed, 145 were injured, and the property losses amounted to more than $7,500,000. These 56 explosions were almost 36 percent of the total number of explosions reported during the period.

It must be recognized, therefore, that the most disastrous losses from dust explosions are occurring in terminal grain elevators, and that satisfactory progress has not been made in the control of dust explosions in this branch of the grain-handling industry. Much of this can be assigned to the lack of provision for adequate dust control during handling, storing, and shipping operations.

In considering this matter several years ago when it was apparent that extensive losses were occurring, the Bureau of Chemistry in the Department of Agriculture learned that many of the dust-collecting systems installed in grain elevators throughout the United States could not be used, or were dismantled because of the objection of the officials having jurisdiction over the weighing of the grain. The weighing departments stated that grain weights were greatly affected by the action of suction used in the collection of the dust. Reports of tests conducted by a number of elevator operators, however, indicated that the weight of the dust removed is almost negligible. Some men experienced in grain-handling stated that less dust is removed by suction than is lost in handling grain by means of poor machinery, with no dust-collecting equipment.

Confronted with these conflicting statements, the Bureau of Chemistry made a preliminary study of the effects of dust collection on the weight of grain. The results of this study showed that much depended on the design and installation of the dust-collecting equipment. In many cases the equipment seemed to have been installed with no knowledge of the fundamentals of good design. In some cases the claims of weighing departments that grain had been drawn out by improper application of suction to remove the dust at certain points between the car which was being unloaded and the scales probably were correct. No information concerning a generally accepted method of applying suction or the proper equipment to use could be obtained. Every elevator seemed to have its own system of dust control and no standards existed. None of the systems was so installed as to permit inspection, nor were any of them so designed that it would be impossible to life grain by increasing the speed of the fan, with a corresponding increase of suction.

It will be necessary to develop and install effective methods for dust control and collection in grain elevators to reduce dust explosion losses. Until this is done it will not be possible to make progress in dust explosion control in terminal grain elevators comparable to what has been accomplished in the control of dust explosions in other grain and milling industries.

EFFECT OF NEW MANUFACTURING PROCESSES

Dust explosions may occur in any industrial plant where combustible dusts are present as the result of the installation of some newly developed equipment. Many of the dust explosions in recent years in the United States have been directly associated with the introduction of new manufacturing processes which have opened up additional sources of ignition, and have resulted in conditions favorable to explosions. It is therefore highly desirable that new manufacturing operations be carefully examined to detect possible dust explosion hazards, and that attention be given to the adoption of preventive measures.

VALUE OF RESEARCH STUDIES ON DUST EXPLOSION AND FIRE PREVENTION

The value of research work on dust explosion and fire prevention which has as its primary object the development of methods and appliances for the protection of human life, foodstuffs, and property must be recognized.

The practical application of the research already done has resulted in a marked reduction in losses from dust explosions and fires in some of the principal grain and milling industries. There still remain many important problems in other industries handling and processing agricultural products that must be studied in order to develop further control and prevention methods.